Eco-Friendliness Evaluation of Separating Wall Systems in Iran Using TOPSIS Method

Hadi Madadi Ghollehzou,[1]
Mohammadreza Tavakkolizadeh[2]
Shahnaz Danesh[3]

1. Introduction

Considering the role and position of separating wall systems in construction, in the present study the environmental effects of common separating wall systems in Iran was investigated. For this purpose, seven environmental parameters including energy, raw material and water consumption in construction process, CO_2 production, thermal resistance, waste produced and aesthetic of the wall systems were considered as evaluation criteria. Regarding these criteria and using the TOPSIS method, this study evaluated the five most common separating wall systems in Iran and determined the most compatible and eco-friendly system. Five different types of walls considered in this study were solid clay bricks (SCB), hollow clay bricks (HCB), autoclaved aerated concrete blocks (AACB), sandwich panels (SP) and gypsum boards (GB). Figure 1 shows the evaluated separating wall systems.

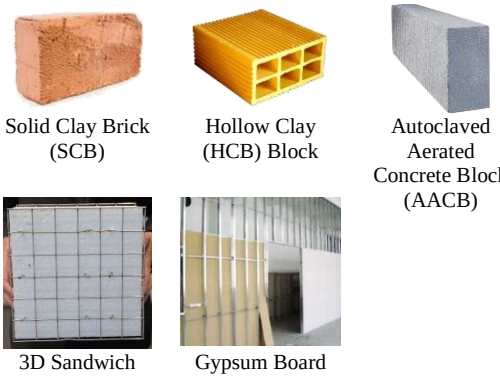

Figure 1. The evaluated separating wall systems

2. Method

The general principles of the TOPSIS method are defining the available alternatives and two hypothetical solutions and finding the optimal one in the process. These two solutions refer to a set of the best and worst values observed in the decision matrix, which are known as positive ideal and negative ideal solutions, respectively. The optimal option in this method is the option that has the shortest distance from the positive ideal solution and at the same time the maximum distance from the negative ideal solution as shown in Figure 2.

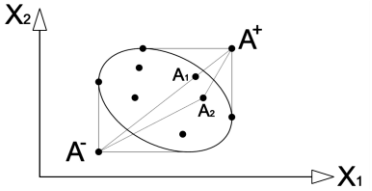

Figure 2. Basic concept of TOPSIS method

3. Data analysis

Figures 3 and 4 show the relative values of the alternatives in each criterion. The climatic realities of Iran have made the "water consumption" with a relative value of 0.195 the most important among the seven environmental criteria. On the other hand, "aesthetic" with a relative value of 0.049 was the least important in view of participant in this study.

One of the notable points of these two figures is the low relative value of AACB walls compared to new separating wall systems such as GB walls and SP in terms of energy consumption during construction.

The results related to the consumption of important resources and raw materials showed that the SP walls, despite having a high value in terms of challenging environment and sustainability, compared to other alternatives, due to its low value in terms of "risk of loss of raw material" and "possibility of recycling" has the lowest value among other alternatives. SCB walls, despite the high consumption of clay materials, have been selected as the best alternatives due to the low relative value of the sub-criterion of "usability in recycling" compared to other sub-criteria.

It was also observed that GB walls have the lowest "water consumption" and the highest relative value in relation to this criterion due to the lack of need for plastering.

1. Graduate Student, Department of Civil Engineering, Ferdowsi University of Mashhad
2. Corresponding author. Assistant Professor, Department of Civil Engineering, Ferdowsi University of Mashhad. Email: drt@um.ac.ir
3. Professor, Department of Civil Engineering, Ferdowsi University of Mashhad

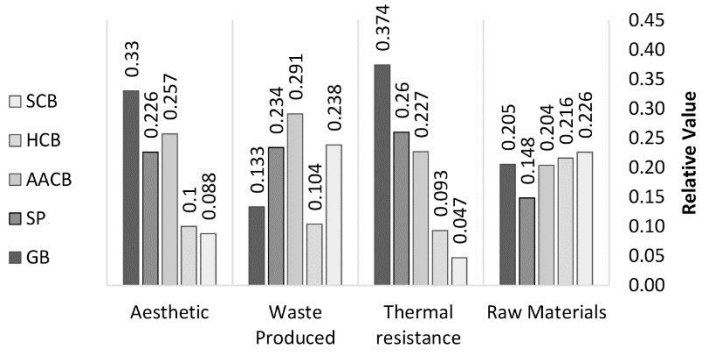

Figure 3. Relative values of alternatives

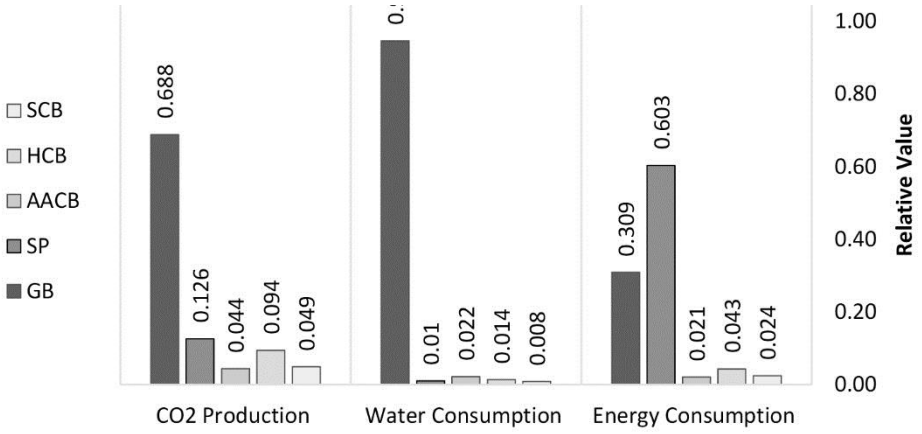

Figure 4. Relative values of alternatives

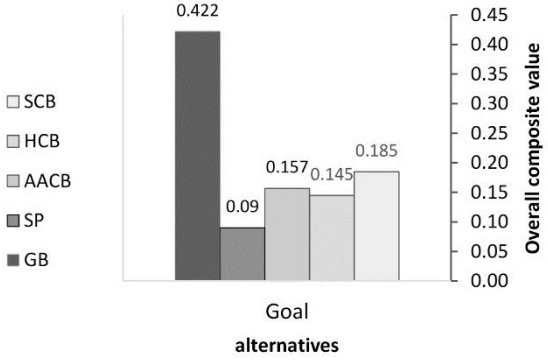

Figure 5. The final ranking of various separating wall systems

Regarding the criterion of "CO_2 production", it can be said that despite the lower energy consumption in the production process of SP walls compared to GB walls, due to high consumption of cement, their relative value in producing harmful gases such as CO_2 was much lower.

The relative value of the alternatives in terms of "thermal resistance" showed that GP walls had the highest resistance due to the use of thermal insulation in the central core and SC walls displayed the lowest heat resistance and highest heat exchange.

The relative values of the alternatives in terms of "aesthetics" also indicated that the AAC, SP, and GB walls had higher relative values due to their larger dimensions than SC and HC walls.

4. Conclusion

The results of this study showed that:

- New separating wall systems were better alternatives in terms of energy consumption, CO2 production and water consumption.
- Gypsum boards and three-dimensional sandwich panel walls were identified as the best and worst separating wall systems in terms of eco-friendliness, respectively.
- Modern separating wall systems did not show a significant advantage over traditional wall systems in terms of using natural resource and raw materials.
- The final values of the selected alternatives for gypsum boards, solid clay bricks, autoclaved aerated concrete blocks, hollow clay bricks and sandwich panels were 0.422, 0.185, 0.157, 0.145 and 0.09, respectively as shown in Figure 5.

It was finally determined that gypsum boards are the most eco-friendly wall system among the five systems evaluated in this study.